JOINT ASSEMBLY FOR CONNECTING A FILIFORM ELEMENT TO A CONNECTION ELEMENT

SPECIFICATION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is the US national phase of PCT application PCT/EP2004/005540, filed 24 May 2004, published 09 December 2004 as WO 2004/106772, and claiming the priority of Italian patent application MI2003A001065 itself filed 28 May 2003, whose entire disclosures are herewith incorporated by reference.

FIELD OF THE INVENTION

The present invention refers to a junction system for connecting a tensile stress-resistant filiform element to a connection element.

BACKGROUND OF THE INVENTION

For some time cables used in multiple applications have been present on the market, for example for furnishing the support rigging for the mast of sailboats, or for the support of poles, or for the pretensioning of beams which must support a bending torque, or for still other structures.

Such cables must possess an adequate resistance to tensile stress, thus they are usually made of metallic material and in particular in steel. Furthermore, such cables must be secured at their ends, for example in a sailboat one outer end is

connected to the top of the mast, and the other end to a connector fastened on the bridge.

Such cables notoriously present several drawbacks, including the fact that the constituent materials have an elevated density and an excessive overall weight for some applications. For example, the weight of the cable which maintains the sailboat mast must be balanced by an additional weight applied to the boat keel. Since the lever arm of the moment exercised by the weight applied to the mast is considerably greater than the lever arm of the moment exercised by the weight applied to the keel, the value of the additional weight applied to the keel must be considerably above the weight applied to the mast. Naturally, this perversely affects boat stability and performance.

Another drawback of traditional cables consists in the fact that the ends are damaged by wear and tear, continuous rubbing, impact, and shearing both by atmospheric agents and by the elements to which they are connected.

Still another drawback of traditional cables is due to the use of extremely expensive materials in order to confer optimal properties of resistance to tensile stress and stiffness.

A further drawback of traditional cables is due to the use of a generally complex joint assembly to a connection element, which may be installed only by highly specialized personnel.

Finally, such traditional cables have the drawback of generating, due to their generally circular-section shape, an increased aerodynamic resistance independent of the direction of the fluid which impacts it.

OBJECT OF THE INVENTION

The object the present invention is, therefore, to provide a junction system for connecting a tensile stress-resistant filiform element to a connection element that permits the elimination of the above-mentioned technical drawbacks of the known technique.

Another object of the invention is to provide a junction system for connecting a tensile stress-resistant filiform element to a connection element where the filiform element has a low density but notable properties of resistance to tensile stress and stiffness such that it has an extremely limited overall weight, ideal for many applications.

Another object of the present invention is to supply a junction system for connecting a tensile stress-resistant filiform element to a connection element that protects the filiform element against damage by wear and tear, continuous rubbing, impact, and shearing both by atmospheric agents and by the elements to which they are connected.

Another object of the present invention is to supply a junction system for connecting a tensile stress-resistant filiform element to a connection element, in which the filiform

element has ideal properties of resistance to tensile stress and stiffness even while being made of inexpensive material.

A further object of the present invention is to provide an easy-to-install junction system for connecting a tensile stress-resistant filiform element to a connection element, even by personnel that are not highly specialized.

Last but not least an object of the present invention is to provide a device for reducing the aerodynamic resistance of a tensile stress-resistant filiform element subject to a fluid flow of variable direction.

SUMMARY OF THE INVENTION

The technical task, as well as these and other objects according to the present invention, are achieved by making a junction system for connecting a filiform element to a connection element, characterized by a tube fitted on an end section of the filiform element and substantially having an eye into which the connection element can be hooked.

According to a further aspect of the present invention, a procedure for making such a joint assembly between a filiform element and a connection element is characterized in that a tube is fitted on an end section of the filiform element, and this tube is shaped such that it forms an eye adapted to be hooked by the connection element.

According to a third aspect of the present invention, a method (and a device) for reducing the aerodynamic resistance of a filiform element subject to a fluid flow of variable direction

is characterized for the mounting of a highly aerodynamic wing profile along at least one section of the filiform element, supported and freely rotating around the filiform element such that it orients itself in the direction of the fluid flow that impacts it.

BRIEF DESCRIPTION OF THE DRAWING

Further characteristics and advantages of the invention shall be more evident from the description of a preferred but not exclusive embodiment of the junction system according to the invention, illustrated as significant and non-limiting in the attached drawings, in which:

FIG. 1 shows a section through a first preferred embodiment of the junction system according to the present invention;

FIG. 2 shows a section through a device for reducing aerodynamic resistance according to the present invention;

FIG. 3 shows an axial section through a second preferred embodiment of the junction system according to the present invention; and

FIG. 4 shows an axial section through a third preferred embodiment of the junction system according to the present invention.

Equivalent parts in the description will be indicated by the same reference number.

SPECIFIC DESCRIPTION

With reference to FIG. 1, a junction system 1 is shown for connecting a filiform element 2 to a connection element (not shown). The junction system 1 has a tube 3 fitted on an end section of the filiform element 2 and substantially defining an eye 4 the connection element can be hooked. In this embodiment, the tube 3 and the eye 4 are made in a single piece.

The tube 3 has a curved section 5 defining the eye 4, and at least a first substantially straight section 6 distal from the outer end 7 of the end section of the filiform element 2. At least the first straight section 6 of the tube 3 may be bonded to the filiform element 2, for example by an adhesive. The first straight section 6 of the tube 3 has a predetermined length such that the tensile stress force is at least partially or completely transferred from the filiform element 2 to the tube 3, corresponding exactly with the first straight section 6 of the tube 3. The first straight section 6 of the tube 3 may be extended, also simply for protecting the filiform element 2 inside it. The tube 3 has flared ends in order to avoid transversely cutting the filiform element 2.

Preferably, the tube 3 also has a second substantially straight section 8, proximal to the outer end 7 of the end section of the filiform element 2. Preferably, the filiform element 2 may be of composite material, for example a continuous longitudinal fiber having a thermoplastic resin matrix, while the tube 3, may be of steel if there are no corrosion problems,

stainless steel if there are corrosion problems, or also of another metallic material or in plastic in other applications.

When increased mechanical strength properties are required, the fibers of the composite material may be of carbon, aramide, S glass or PBO. Otherwise, for reasons of economy and where lower mechanical properties are required, glass fibers may be employed. It may be advantageous to combine different composite materials to make the filiform element 2, for example an internal composite material of carbon fibers to confer the desired stiffness and an external composite material in aramide to confer resistance to abrasion. The thermoplastic matrix may be made of TPU, nylon, PEEK or polypropylene.

The filiform element 2 may be a composite round strand, or a plurality of composite round strands, aligned or intertwined among themselves. The resinous matrix of the constituent composite of the filiform element 2 may alternatively be of thermosetting type. If the round strands are not of circular cross section, they may be assembled such that they give rise to a substantially circular configuration. The filiform element 2 may also be of plastic or metal, for example steel, where weight is not a critical factor in the application. The facing surfaces of the tube 3 and the filiform element 2 may define spaces specifically made to contain the adhesive material.

The filiform element 2 may have a protective coating (not shown) against ultraviolet rays and/or against attacks of chemical nature and/or against damage of mechanical origin. The

filiform element 2 and/or its protective coating may additionally have both a predetermined coloration for identifying the diameter of the filiform element 2 and/or for visually indicating the filiform element 2, and length markers for facilitating the measurement of the filiform element 2 during the making of the junction system. The junction system has means for locking the eye 4 closed, in particular formed by a ring 10 applied around the neck of the eye 4.

The procedure for making a system for connecting the filiform element 2 to a connection element foresees fitting the tube 3 on the end section of the filiform element 2, and forming the tube 3 such that it defines the eye 4. In such a procedure, the filiform element 2 may be bonded to the tube 3 in order to more efficiently transfer the tensile stress load from one to the other. The bond, as shown, may be made with an adhesive applied to the outer surface of the filiform element 2 before the introduction of it into the tube 3, or by applying a low-viscosity adhesive on the interface between the filiform element 2 and the tube 3 after the forming them, the adhesive penetrating by capillarity or by applying a vacuum or pressure at an end of the tube 3.

Alternatively, if the filiform element 2 is of composite thermoplastic material, the bond may be formed by at least partial melting of the resinous matrix of the composite material so it adheres to the inner surface of the tube 3.

Naturally, the length required for the transfer of the load from the filiform element 2 to the tube 3 depends on a plurality of factors including, among others, the quality of the interface and the properties of the adhesive. A tighter contact at the interface and/or a higher adhesion coefficient reduces the transfer length.

To make a joint assembly of the filiform element 2 of thermoplastic composite material to the connection element, a kit comprising a bending device (not shown) for the tube 3 will suffice, having means for heating adapted to simultaneously heat the filiform element 2 and the tube 3 to a predetermined temperature at which the filiform element 2 and the tube 3 become malleable, to be shaped such that they substantially define the eye 4.

Optionally, the heating and the bending of the filiform element 2 and the tube 3 may be undertaken by especially dedicated devices. For example, the heating may be executed by a hot air pistol, by an oven, by heated metallic plates etc. while the bending may be achieved by a traditional bending machine. Naturally, if the resinous matrix of the composite is thermosetting, the bending is executed at cool temperatures.

One particular junction procedure is described below :

The filiform element 2 is a strand of 5 mm diameter and 1,000 mm length, made of a thermoplastic composite material of carbon fiber embedded in an ETPU matrix. The tube is a stainless steel tube of 300 mm length.

The end 200 mm of the tube is heated to 160°C.

The tube and the strand inside it are bent such that they form a hooking eye; they are then cooled.

Two stainless steel rings 10 mm long are flattened such that they assume an oval shape, and the end of the not-yet-shaped strand is inserted in them.

The end of the not-yet-shaped strand is inserted into a second stainless steel tube 300 mm long, after which the other end of the strand is shaped in order to form the second hooking eye.

Each ring is seamed at the neck by a corresponding eye.

Finally, each eye is hooked to a corresponding connection element.

With reference now to FIG. 3, the junction system 1 has removable connection means 100 between the tube 3 and the eye 4. Such connection means comprise a threaded stem 101 that extends from the eye 4 and screws into a first end 102 of the tube 3.

The junction system 1 has an retaining element 103 adapted to prevent the the filiform element 2 from pulling out of a second end 104 of the tube 3. The retaining element 103 consists of a pin inserted axially into the end of the filiform element 2 positioned in the tube 3, and has a maximum cross section greater than the inner clearance of the tube 3. In a preferred form, the pin 103 has a conical or frustoconical shape, in order to facilitate centering with respect to the generally

cylindrical filiform element 2, and to obtain a homogenous deformation of the filiform element 2 during penetration.

The filiform element 2 is preferably of thermoplastic composite material, directly or indirectly heatable to a softening temperature adapted to permit penetration of the pin. The filiform element 2 may be softened by an external heat source applied directly to it, or by friction generated during pin penetration, or by heating the pin first and/or during its insertion, or by heating the tube first and/or during pin insertion.

In the junction system 1 now illustrated the filiform element 2 is axially hollow in order to facilitate the pin penetration. The filiform element 2 may more generally be solid or of empty or hollow section in order to be lighter.

With reference now to FIG. 4, the junction system 1 has an eye 4 formed in a single piece with the tube and the means for screw connection 105 being between the inner surface of the tube 3 and the outer surface of the end section of the filiform element 1. At least at the region of engagement between the thread of the filiform element 2 and the counter-thread of the tube 3 that defines this screw connection means, an axial void 106 in the filiform element 2 being provided that permits it to radially deform . Preferably, in fact, the thread of the filiform element 2 is preferably formed by inserting a pin in the axial void 106 in order to radially push the filiform element 2

from the inside toward the outside against the wall of a mold having the shape of the thread.

The filiform element 2 of the above-discussed embodiments may be constituted in its entirety by extruded longitudinal fibers. Nevertheless it is equally conceivable that the filiform element 2 has a first section in extruded longitudinal fiber comprising the end section on which the tube 3 is fitted and a second section extending from the first section in free or intertwined non- extruded longitudinal fibers.

According to another aspect, the present invention includes a method for reducing the aerodynamic resistance of a filiform element subject to a fluid flow of variable direction. Such method foresees the application of an element of wing profile along at least a section of the filiform element, supported and freely rotating around the filiform element such that it orients itself in the direction of the fluid flow that impacts it.

An element with highly aerodynamic wing profile is illustrated in FIG. 2, which as an example makes reference to a shroud 30, in particular in composite material, which may be used to brace the vertical mast of a sailboat.

As known, the aerodynamic resistance D of a body struck by a fluid flow is expressible as: $D = C_x \times L \times W \times V^2$ where C_x is a factor related by the body shape, L is the length of the body, W is the diameter of the body, and V is the relative velocity between the body and the fluid. It should be noted that with L,

W and V the same the wing profile of the aerodynamic element here illustrated has a C_x substantially equal to half that of the circular section of the shroud.

The element with highly aerodynamic profile is constituted by a wing-shaped foil 31 having elastically deformable opposing edges 32 for the snap-lock introduction of the shroud 30. The foil 31 is made from a plastic extrusion, preferably colored so that it is highly visible. The foil 31 also has at least a first extension, in particular two extensions 33, jutting out from its inner surface to join the foil 31 to a precise point on the longitudinal length of the shroud.

Possibly, the foil 31 may have a plurality of extensions (not shown) jutting out from the inner surface, for example angularly-spaced and radially-oriented with respect to the shroud 30, in order to join the foil 31 to a precise point on the longitudinal length of the shroud 30 having a substantially smaller diameter than that of the maximum chord of the curved part of the foil 31. In such a manner the foil also operates as an element of protection of the shroud from accidental impact.

The junction system for connecting a filiform element to a connection element thus conceived is susceptible to numerous modifications and variants, all coming under the scope of the inventive concept; in addition, all details may be substituted by technically equivalent elements. In practice, any materials of any size may be used, according to the requirements and to the state of the art.